Threatened and Endangered Species Valuation: Literature Review and Assessment

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Valuation of Threatened and Endangered Species

Economic valuation of threatened or endangered (T&E) species has produced value estimates for over forty species, consisting primarily of mammals, fish, and birds. Because the economic value of T&E species cannot be reflected by a market price, the majority of these studies have relied on the contingent valuation (CV) method. The CV method estimates the economic value of a T&E species by placing survey respondents in a hypothetical market setting created for a particular species, or suite of species, and asking them their willingness to pay to either avoid a total loss of a population (prevent extinction) or increase the population's size. Respondents pay for, or pay to prevent, the population change described in the hypothetical market through a specified payment vehicle. Often the payment vehicle is a contribution to a preservation or trust fund, though other payment vehicles include increased taxes, increased commodity prices, lifetime memberships to an organization, and increased park fees. Additionally, the frequency of payment and the payment amount are specified in the hypothetical market. Some studies ask respondents an open-ended question concerning their maximum willingness to pay, while other studies use a dichotomous choice format, asking respondents to say yes or no to a specified bid amount(s). While estimating value through hypothetical markets and unobserved behavior is not without critics (see Diamond and Hausman 1994 for a critical review of the CV method), contingent valuation has been upheld by the US District Court of Appeals (Department of Interior 1989), and has been approved for use in cost-benefit analyses (US Water Resources Council 1983). In addition, the NOAA Panel on Contingent Valuation (Arrow et al. 1993) found the method to produce credible value estimates when specific survey development and implementation protocols are followed.

Associated with T&E species are several types of value, including use value, option value, existence value, and bequest value. In the case of T&E species, use value refers to a passive use value such as viewing or photographing. Existence value is the value derived from simply knowing the species exists in it's natural habitat regardless of the potential for any future use. Option value refers to the value of preserving a species so that it may be used in the future for a variety of purposes, such as genetic or medicinal applications. Bequest value refers to the value of preserving the species for future generations. Collectively these values represent the total economic value of T&E species (Randall and Stohl 1983). It is assumed that respondents in a CV survey who are willing to pay for species preservation are motivated by some or all of these types of value.

The primary objective of this paper is to review the valuation literature for T&E species and provide value estimates for species under the management of NOAA's Office of Protected Resources (OPR). OPR is charged with implementation of the Endangered Species Act of 1973 (ESA) for marine and anadromous species, and develops, implements, and administers programs for the protection, conservation, and recovery of species protected under the ESA. Value estimates for marine and anadromous species can be useful to NOAA for analytical or policy purposes, as well as public outreach and education. A secondary objective of the paper is to examine issues concerning T&E species valuation that warrant attention and propose strategies that may address these issues in future research.

Data Sources

The studies used for this paper were obtained by searching bibliographic databases available through the NOAA library. This resulted in 22 studies, including one meta-analysis of CV estimates for T&E species (Loomis and White 1996), one summary of CV estimates for T&E species (Eagle and Betters 1998), and a number of studies which value more than one species, by either asking respondents about their value for a suite of species or by using a split sample survey design. Selecting the studies that pertained to a marine or anadromous fish species under the management of OPR resulted in 10 published documents, including the meta-analysis and CV summary paper noted above. For this paper, value estimates were taken directly from the original source paper, with the exception of Hageman's (1985) estimates. The selected studies provided values for nine species in NOAA's OPR: the short nosed sturgeon, gray whale, loggerhead sea turtle, Atlantic salmon, bottlenose dolphin, California sea otter, Hawaiian monk seal, northern elephant seal, and humpback whale. These nine species represent only a fraction of all of the species managed by OPR. Value estimates and study details are provided in Table 1. Estimates have also been standardized to 2003 dollars using the consumer price index. The abbreviations OE and DC in Table 1 refer to an open-ended or dichotomous choice willingness to pay question. All estimates are per person, with payment vehicle and frequency indicated in the table unless otherwise noted. Values for Pacific salmon and steelhead and Atlantic salmon are provided, though only evolutionarily significant units are considered threatened or endangered.

Who Pays and Why?

A review of the CV literature for T&E species illustrates the importance of two pieces of information obtained from most studies. First, the species value itself is important for calculating welfare effects of potential policy changes or for use in cost-benefit or other types of analyses. For example, Eagle and Betters (1998) compare fines mandated by the Endangered Species Act to CV estimates and find that on average the value of a T&E species is more than three times higher than the highest fine, concluding that the law undercompensates the public for the taking of a species. The second piece of information concerns factors that affect value estimates - who is willing to pay for species preservation and why? From the literature, two categories of factors address this question. First, factors relating to the respondent appear to affect willingness to pay. These factors may include respondent characteristics, environmental attitudes and environmental ethics. Several studies show that environmental attitudes, respondent education, and respondent income affect the likelihood of payment (Kotchen and Reiling 2000; Olsen et al. 1991; Giraud et al. 2001). Second, factors relating to the information presented in the survey, such as the size of the proposed change in the population, payment vehicle, and payment frequency, may affect willingness to pay. Studies have shown that there are significant diminishing marginal returns to increases in a T&E population, and that frequency of payment, payment amount, and type of species (bird or marine) affect the likelihood of paying for preservation (Loomis and Larson 1994; Loomis and White 1996; Stevens et al. 1991).

One piece of information that CV surveys typically address in an relatively unrealistic manner is the issue of the probability of future supply under the proposed preservation program. For example, in the case of avoiding extinction, respondents are asked to assume that the described change will definitely occur without a preservation program. In cases of population increases, respondents are either asked to assume the increase will occur, or the issue is not specifically addressed. In the latter case, respondents may have very little information with which to base such a decision on, which may lead to nonpayment and/or protest responses. For example, Stevens et al. (1991) determined that a portion of the 16% of nonpayment bids were due to protest responses from respondents who lacked confidence in state and federal agencies abilities to restore populations of anadromous fish. Whitehead (1992) addresses the issue of supply probability by first determining respondents perception of loggerhead turtle extinction without a preservation program and subsequently stating that the with a preservation program the turtle will definitely not go extinct in the next 25 years. The difference between the respondent's perceived risk and the management induced probability serves as a measure of extinction risk reduction, and is a significant variable in the willingness to pay model. In all CV studies reviewed, the probability of supply was either not specified or respondents were asked to assume that the preservation program will succeed, rendering the probability of future supply 100%.

Few studies have examined the effect of demand uncertainty on willingness to pay. This may be due, in part, to the fact that non-use values have traditionally been associated with T&E species. However, with increases in whale watching and other ecotourism activities, use values may be a significant component of the value of a T&E species, and thus demand may have an important effect on willingness to pay. Some research has shown that willingness to pay increases as the probability of using a resource in the future increases (Whitehead 1992; Olsen et al. 1991). Demand uncertainty may play a particularly significant role for T&E species that may, in the future, have a consumptive use value. For example, some anadromous fish species currently under OPR management, such as certain populations of Steelhead Trout (Northwest) and Atlantic Salmon, and the Nassau Grouper, may provide an important recreational fishery if populations become sustainable and the species are delisted. In cases such as this, future demand when a sport fishery reopens may have an important effect on respondent willingness to pay. In addition, there may be an interaction effect among the probability of future supply, future use, and future demand.

A Multi-Attribute Approach for Valuing Protected Resources

To date the approach taken to measure passive and non-use values has been the CV method (Giraud et al. 2001). However, there are other stated preference methods that could be employed to value T&E species preservation, such as choice experiments or conjoint analysis (see Adamowicz et al. 1998 for an application of choice experiments in estimating passive use value). These methods offer a multi-attribute approach to valuation, and can be appropriate for valuing a good that is characterized by a suite of attributes. For example, the discussion above suggests that both respondent characteristics and information presented in a CV survey may affect willingness to pay. Put another way, a person's utility for preservation is a function of respondent characteristics and a suite of attributes such as size of population change, payment vehicle, cost of the program, supply uncertainty, or other attributes that characterize the preservation program. A multi-attribute approach allows the effect that each attribute has on the probability of choosing a preservation program to be quantified, and in addition, quantifies the trade-offs respondents are willing to make among the programs attributes. An example might be the trade-off between the cost of the program and the supply uncertainty. Using a multi-attribute approach one could calculate what respondents would pay to increase the probability that a preservation program would succeed. The situation is realistic because agencies and recovery programs cannot know for certain the outcome of their efforts, and adding the probability of success provides additional information to help respondents make decisions that reflect real life circumstances.

The approach is well suited for T&E species that may have a consumptive use value in the future. For example, when valuing a currently protected fish species that may ultimately recover and support a recreational fishery, a multi-attribute approach can estimate the implicit value of increasing or decreasing the chances that a sport fishery will be established. Also, the relative importance of a future sport fishery as compared to other attributes of a preservation program can be ascertained. In addition, a multi-attribute approach works well for cases where different management strategies can be used to achieve the outcome of a preservation program. In such cases, the effects of each strategy on the likelihood of accepting or rejecting a preservation program can be quantified. Knowing which types of management strategies are preferred by the public may be useful for public outreach and education efforts.

The key attributes of a preservation program are generally determined by the objectives of the research and an extensive qualitative phase consisting of focus groups and pre-tests. However, for illustrative purposes of this paper, a suite of *hypothetical* attributes for a preservation program for a protected anadromous fish are presented below.

Population Change

Describes the change proposed for the population, such as the size of a increase, e.g. population will double, or avoiding extinction. Respondents should be informed of the current status of the population.

Program Success

Describes the chances of the programs success, such as high, moderate, low, or as a probability that the program will succeed.

Program Implementation

Describes how the program will be implemented. Because management plans exist for most protected species through the federal government, this attribute may describe additional measures to be taken by outside entities or different management options that could be used under the current protection program.

Future Sport Fishery

Describes the potential for a future recreational fishery once the population change has occurred.

Cost

Describes the cost of the program and the method of payment.

As stated previously, the majority of valuation studies for T&E species have employed the CV method. While these studies have produced extensive information concerning public values for species preservation, a multi-attribute approach may have several advantages over the traditional CV method. First, the multi-attribute approach allows one to value individual attributes of a preservation program. This may help agencies or organizations design future programs that, when possible, accommodate public preferences. Further, multi-attribute surveys do not ask respondents specifically about willingness to pay, but rather, provide them with information about many aspects of different progams and ask them to choose the program they would prefer. Providing more information as well as more program options may reduce protest or non-responses. Additionally, if the status quo is offered as an alternative, e.g. choosing not to pay for any program, the endowment effects, or the utility gained or lost by moving away from the status quo, can be examined (Adamowicz et al. 1998). Aside from any advantages over the CV method, research that employs a multi-attribute approach to value a protected resource would have a variety of positive outcomes, including

- Revealing the public value of a protected resource
- Revealing a separate component of value related to any future consumptive use of the resource, if appropriate
- Identifying key attributes of protected resource preservation programs and determining the relative importance of each attribute in public acceptance or rejection of the program
- Calculating welfare effects of different policies that may affect any of the attributes of the preservation program
- Expanding the methodological scope of the T&E species valuation literature

Table 1. Summary of Literature Values (Use and Non-use) for NOAA Protected Resources

Reference	Study Date	Species	Proposed Change	User WTP	Non-User WTP	Survey Region	Sample Size (n)	Response Rate	Payment Vehicle and Frequency	Comments
Kotchen and Reiling, 2000.	1997	Short-nosed sturgeon	Restoring a self-sustaining population		$27[a] **In 2003 $** $30.89	Maine	635	63%	One time payment to species protection fund through increased taxes DC	Program implementation is through protecting species from future dredging and water pollution
Loomis and Larson 1994.	1991	Gray whale	Increasing populations by 50% and 100%	$25 for 50% $29 for 100% lump sum **In 2003 $** $33.70; $39.09	$16 for 50% $18 for 100% **In 2003 $** $21.57; $24.26	CA	User - 1003 Non-user 890	User 71% Non-user 54%	One time payment directly to protection fund OE	Users are whale watchers during the past five years; non-users haven't whale watched in the last 5 years
Hageman 1985.	1984	Gray and Blue whale	Pay to prevent population decrease from 16,000 to 1,300 animals		$27[a] **In 2003 $** $47.71	CA	180	21%	Annual increase in federal taxes DC	
Whitehead 1992.	1991	Loggerhead sea turtle	Reducing the risk of extinction to zero for the next 25 years		$33[a] **In 2003 $** $44.48	NC	225	35%	One time payment directly to preservation fund DC	Respondents first asked their opinions about the chance for sea turtle survival, then told the fund will reduce the risk to zero

Reference	Study Date	Species	Proposed Change	User WTP	Non-User WTP	Survey Region	Sample Size (n)	Response Rate	Payment Vehicle and Frequency	Comments
Stevens et al. 1991.	??	Atlantic salmon	Preventing extinction in New England		$7.93[a] **In 2003 $** $10.69	MA	1000 (N)	not provided	Payment directly to preservation fund every year for 5 years DC	Budget cuts will eliminate current preservation programs and private preservation fund must be established to prevent extinction. Study was prior to closing the seven river Maine salmon fishery
Morey et al. 1993	1988	Atlantic salmon	Eliminate salmon fishery	Mean CV -$810 **In 2003 $** -$1091.89		Maine	168	not provided	Opp. cost of time modeled as 1/3 the wage rate	Study was prior to closing the seven river Maine salmon fishery, though the study was on the Penobscot, not one of the 1995 closures. Travel cost study. Repeated NL model with participation and site choice w/income effects
Samples and Hollyer 1990.	1988	Monk seal	Pay to prevent extinction		$62 - $103[a] depending on survey treatment lump sum **In 2003 $** $96.22-$159.85	HI	66	40%	One time payment to preservation fund DC	Program implementation through increased medical attention to species to fight threatening disease

Reference	Study Date	Species	Proposed Change	User WTP	Non-User WTP	Survey Region	Sample Size (n)	Response Rate	Payment Vehicle and Frequency	Comments
Samples and Hollyer 1990.	1988	Humpback whale	Pay to prevent extinction		$125 - $142[a] depending on survey treatment lump sum **In 2003 $** $194-$220	HI	66	40%	One time payment to preservation fund DC	Program implementation through increased medical attention to species to fight threatening disease
Hageman 1985.	1984	Bottlenose dolphin	Pay to prevent loss		$17.73[a] **In 2003 $** $31.33	CA		21%	Annual increase in federal taxes DC	
Hageman 1985.	1984	California sea otter	Pay to prevent extinction		$20.75[a] **In 2003 $** $36.67	CA	174	21%	Annual increase in federal taxes DC	
Hageman 1985.	1984	Northern elephant seal	Pay to prevent loss		$18.29[a] **In 2003 $** $32.32	CA		21%	Annual increase in federal taxes DC	

Reference	Study Date	Species	Proposed Change	User WTP	Non-User WTP	Survey Region	Sample Size (n)	Response Rate	Payment Vehicle and Frequency	Comments
Olsen et al. 1991	??	Pacific salmon and steelhead	Double the population in Columbia River Basin	$58.56-$74.16 depending on type of user **In 2003 $** $78.94-$99.97	$26.52 **In 2003 $** $35.75	Pacific Nwest	2907	72%	Increase on monthly electric bill; annual payment calculated OE	Program implementation through mitigation and enhancement activities by the regional power company. Divided user group into "potential users" (lower estimate) and "users" (higher estimate)

[a] Does not distinguish between user and non-user.

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